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# Evaluating SCM Practices with the SCM Scorecard: Evidence from an International Study

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**Abstract**:

Supply chain management (SCM) is concerned with system-level management of material and information flows. However, despite the prevalence of the concept, there is a lack of systematic tools to collect comparable firm-level observations on SCM practices, as well as to study empirically the purported relationship between SCM practices and financial performance. One tool for such evaluation is the SCM Logistics Scorecard (LSC). This paper reports a study to compare firm-level Finnish (n=53) and Japanese (n=290) LSC responses as well as the relationship between LSC scores and financial performance within the Finnish data set. Differences between the data sets from the two countries are evaluated along with the observation that higher LSC and LSC-based factor scores are mildly positively associated with some financial indicators. Finally, the role of the SCM Scorecard as an evaluation tool of SCM practices in the international context is discussed.

**Keywords**: Supply Chain Management, SCM, SCM Scorecard, Measurement, Financial Performance

# 1 INTRODUCTION

Supply chain management (SCM) is concerned with system-level management of material and information flows along chains of companies positioned along the value chain for a specific good or service. The main tenet is that by viewing the supply chains holistically and not just from a single company point of view, better operational performance both in terms of efficiency and customer satisfaction will follow. Eventually, this will lead to better financial performance. In particular, return on investment will grow, since, asset utilization is optimized, costs are minimized, and revenues maximized.

However, there is a lack of systematic tools to build a comparable database on SCM practices. Although there are abundant singular studies on the extent of SCM practices in various countries (see for example Kemppainen and Vepsäläinen 2003, Tan 2002, Sahay et al. 2003) these studies use their own measures, which while converging, are still not the same and therefore makes it is hard to compare the results of different studies. In addition, there are not so much empirical studies examining the purported relationship between SCM practices and company performance. Notable exceptions include the works of Frohlich and Westbrook (2001), Vickery et al. (2003), and Li et al. (2006). The findings of these statistical studies support the notion that there truly are positive relationships, but these studies use their own measurement schemes of the SCM-practices and rely mostly on subjective performance evaluations. A recent study (Dehning et al. 2006) found a positive relationship between actual financial performance and the use of IT-solutions for SCM – an interesting result, but the drawback is that only SCM-IT solutions are considered, not the wide spectrum of SCM-activities (as described, for example by Lambert and Cooper 2000).

To evaluate SCM-practices with a systematic tool, Tokyo Institute of Technology developed a measuring scheme to evaluate the use of SCM practices at the company level. This measuring scheme, entitled the SCM logistics scorecard (LSC), has been used to build a database of Japanese companies since 2001 (Suzuki et al. 2006). By 2006, data from 328 Japanese companies had been recorded with the LSC. The analysis of the Japanese data has revealed significant positive associations with high LSC scores and financial performance. Later, the data has been collected also in Thailand and China (Suzuki et al. ibid., Yaibuathet et al. 2006).

In 2004, the LSC tool was brought to Finland by Logistra Consulting Oy and Logy (the Finnish Association of Logistics). A web-based version of the LSC was subsequently developed under the EGLO program (logistics development program of the Ministry of Transport and Communications Finland). The LSC tool has been used to collect data from Finnish companies in two phases (in 2004 and 2006). Data were collected from both manufacturing and non-manufacturing companies to provide a wider base of respondents, including the important wholesales, retail, and logistics industries.

This paper has three objectives. First, data collected with the LSC in Finland are analyzed and the results are compared with the Japanese data. Second, a factor analysis is conducted to evaluate the LSC-instrument itself and compare the results of the factor analyses between Finnish and Japanese data sets. Third, the relationship between LSC scores of Finnish companies and financial data collected from separate source is evaluated, to examine whether there is a link between the extent of SCM practices – as measured with the LSC – and selected financial outcomes. Finally, the role of the LSC as an international comparison tool is evaluated.

# 2 METHODS AND DATA

## 2.1 The SCM Logistics Scorecard

The SCM Logistics Scorecard (LSC) has been developed to reflect various aspects of supply chain management. Researchers at Tokyo Institute of Technology evaluated various SCM-related managerial scorecards, such as the ECR scorecard, QR scorecard, Kurt Salmon Associates Millennium readiness profile scorecard, and SCOR scorecard. After this analysis, the items for the LSC were selected to capture various aspects of SCM. The LSC consists of four main areas:

- Corporate strategy & interorganizational alignment
- Planning and execution capability
- Logistics performance
- IT methods and implementation

Each four areas consist of five individual items resulting in a scorecard with 20 individual questions (see Appendix). The measurement scheme used in the scorecard is a 5-point scale allowing also fractions of points given. Each scale point is given a benchmark level. For each item, the responding company is asked to indicate which of the given levels best reflects its situation. If the most suitable level is between the given levels, also fractions of points can be given. In each item, Level 1 reflects the most rudimentary level, while Level 5 reflects the highest level. Thus, the higher the LSC scores, the higher the level of SCM, as measured with the LSC items.

## 2.2 Study data

This study consists of three sources of data: the Japanese LSC database, the LSC data collected in Finland, and background variables for the Finnish companies supplied by a third party. The study data and their sources are described in Table 1.

Table 1: Data sources in the study

| Data | Source |
|---|---|
| Japanese responses to 20 LSC items | Japanese LSC database [1)] |
| Finnish responses to 20 LSC items | Finnish data collection [2)] |
| Industry of the Finnish respondents | Balance Consulting [3)] |
| Most recent sales of the Finnish respondents | Balance Consulting |
| Most recent employee number of the Finnish respondents | Balance Consulting |
| Financial indicators of the Finnish respondents | Balance Consulting |

1) These data were provided to the use of this study by Tokyo Insitute of Technology

2) The Finnish data were collected with the aid of the SCM Scorecard web-portal of the Finnish association of Logistics (32 responses) and by personal contacts with the companies (21 responses)

3) Balance consulting is an independent firm specializing in analyzing financial data of firms. Its services include the sales of anlayzed financial data for those who need it.

The Japanese data were obtained for this study from the Japanese database of LSC scores. Japanese data has been colleted since 2001, with various methods, including personal interviews with the companies, as well as e-mail communication. Currently, the database includes 328 responses. Of these responses, 290 were usable for the analyses of this study, since the 38 omitted responses did not include answers for all of the 20 LSC items.

The Finnish data were collected in two phases, resulting in a database of 58 responses. Of these, 5 answers were not usable, due to data inconsistencies and invalid respondent industries. Of the 53 usable responses, 21 were collected with e-mail communication in 2004. Starting from February 2006, Finnish data were collected through a web-portal including the LSC items (http://logistiikka.planeetta.com/lsc/). 32 answers were collected through this web-version of the portal, in which the respondents browsed to the page, filled the LSC and obtained a feedback

result based on their answers. The Finnish data was collected using both the English and Finnish versions of the LSC: the respondents could select which language they would like to use.

It is important to analyze whether the Finnish first-stage and second-state data collection has resulted in some bias and whether they are distinct or similar groups. Therefore, the average total score of the two samples was tested with a two independent sample t-test. After testing that the two samples had the same total score variance (F-test, one-tailed p=0.15), a two-sample t-test assuming equal variances showed that the difference in average total score in the two samples was not statistically significant (one-tailed p=0.13, two-tailed p=0.26). Therefore the two samples of Finnish data (n=21, n=32) have, based on the total LSC score, similar statistical properties and can be analyzed as one group.

Four financial indicators were selected for the study. Return on investment (ROI) is usually considered a typical outcome of SCM-efforts (see for example Dehning et al. 2006). ROI is measured as percentage of profits relating to invested assets. Low inventory commitment is typically considered a practical outcome of SCM-activities (see for example Frohlich and Westbrook 2001). Two inventory commitment measures were used: inventory days of supply (inventory level in relation to material consumption) and inventories as percentage of sales. The lower these measures are, the higher the efficiency. Finally, we included also a measure on cash flow. In this study, a rough estimated of cash flow was used by adding to company net profits the depreciations that are typically non-cash items. To compare the measure among companies, this estimate of cash flow measure was divided by company sales. The financial measures and their calculation formulas as used in this study are given in Table 2.

Table 2: Financial indicator variables used in the study

| Indicator | Description | Formula |
|---|---|---|
| ROI-05 | Return on investment in 2005 | [(Net profit + taxes + financial expenses) / Invested capital on average] * 100 |
| Inv.DOS-05 | Days of supply of material inventories in 2005 | [Material inventories / (Material and goods purchases in 2005 - Increase in inventories] * 365 |
| Inv/sales-05 | Inventories as percentage of sales in 2005 | [Inventories / Sales] * 100 |
| CF/sales-05 | Estimate of cash flow as a percantage of sales in 2005 | [(Net profit + depriciations) / Sales] * 100 |

The financial measures were collected from an independent company specializing in the analysis of financial data of companies. Therefore, the financial measures offer an objective view of the respondents. However, there is one possible source of bias: the financial indicators could be obtained in some cases only at group level. Therefore, for some respondents the financial indicators may not be strictly the same for the specific unit they gave their LSC answers from. However, the group level financial indicator can be assumed at least to reflect the level of the financial indicator for the responding business unit.

## 2.3 Respondent profile

Tables 3 and 4 present the respondent profile of Finnish and Japanese data sets in terms of size and industry. The Finnish sample of 53 companies includes 28 manufacturing and 25 non-manufacturing respondents (non-manufacturing including logistics service providers, wholesalers, retailers and other companies). Thus there is a fair representation of different kinds of companies along the supply chain. The Japanese data is slightly more weighted on manufacturing companies, with approximately two-thirds of responses from manufacturing industries. The rest of the companies are classified in the category of non-manufacturing

companies (including companies in physical distribution activities, including distributors and logistics service providers, with the bulk of the companies in the sample being logistics service providers). The analysis of the size of the respondents (number of employees) within the Finnish and Japanese data sets reveals that the Japanese data includes significantly higher proportions of larger companies. While half of companies in the Japanese sample have over 1001 employees, only one quarter of Finnish companies have over 1001 employees. On the other hand, the Finnish data set is more balanced among companies of different sizes.

Table 3: Respondent industry

| | Finnish data set | | Japanese data set | |
|---|---|---|---|---|
| **Industry** | **Number of companies** | **% of companies** | **Number of companies** | **% of companies** |
| Manufacturing | 28 | 53 % | 205 | 63 % |
| Food | 1 | 2 % | 38 | 12 % |
| Chemistry | 1 | 2 % | 54 | 16 % |
| Fiber, pulp and paper | 2 | 4 % | 19 | 6 % |
| Electronics | 6 | 11 % | 55 | 17 % |
| Metal (incl. automobile) | 12 | 23 % | 26 | 8 % |
| Other | 6 | 11 % | 13 | 4 % |
| Non-manufacturing | 25 | 47 % | 123 | 38 % |
| Total | 53 | 100 % | 328 | 100 % |

Table 4: Respondent size

| | Finnish data set | | Japanese data set | |
|---|---|---|---|---|
| **Number of employees** | **Number of companies** | **% of companies** | **Number of companies** | **% of companies** |
| <20 | 1 | 2 % | 12 | 4 % |
| 21-50 | 5 | 9 % | 7 | 2 % |
| 51-100 | 5 | 9 % | 15 | 5 % |
| 101-200 | 8 | 15 % | 36 | 11 % |
| 201-500 | 12 | 23 % | 41 | 13 % |
| 501-1000 | 7 | 13 % | 37 | 11 % |
| ≥ 1001 | 13 | 25 % | 155 | 47 % |
| Missing data | 2 | 4 % | 25 | 8 % |
| Total | 53 | 100 % | 328 | 100 % |

# 3 RESULTS

## 3.1 LSC score comparison

T-tests for two independent samples were conducted to test the differences between the Finnish and Japanese respondents. The analyses were conducted on the total and area levels of the LSC and examining the results on total sample level, as well as breaking the sample into manufacturing and non-manufacturing industries.

Table 5: LSC score comparison (two independent samples t-tests)

| | All (FIN) | | | All (JAP) | | | FIN vs JAP | |
|---|---|---|---|---|---|---|---|---|
| | *n* | *Mean* | *Stdev* | *n* | *Mean* | *Stdev* | *t-test* | *p to reject Ho* |
| Total LSC score | 53 | 56.56 | 12.02 | 290 | 58.37 | 11.26 | -1.066 | 0.144 |
| Corporate strategy & Interorganizational alignment | 53 | 3.04 | 0.70 | 290 | 3.04 | 0.64 | 0.083 | 0.467 |
| Planning and execution capability | 53 | 2.76 | 0.72 | 290 | 2.90 | 0.62 | -1.481 | 0.070 |
| Logistics performance | 53 | 2.59 | 0.76 | 290 | 2.78 | 0.71 | -1.809 | 0.036 |
| IT methods and implementation | 53 | 2.92 | 0.70 | 290 | 2.96 | 0.67 | -0.366 | 0.357 |

Ho: Mean value of groups (all [JAP], all [FIN]) is the same
p-values ≤ 0.05 are highlighted

| | Manufacturing (FIN) | | | Manufacturing (JAP) | | | FIN vs JAP | |
|---|---|---|---|---|---|---|---|---|
| | *n* | *Mean* | *Stdev* | *n* | *Mean* | *Stdev* | *t-test* | *p to reject Ho* |
| Total LSC score | 28 | 53.30 | 10.16 | 189 | 58.59 | 10.84 | -2.427 | 0.008 |
| Corporate strategy & Interorganizational alignment | 28 | 2.89 | 0.70 | 189 | 3.05 | 0.64 | -1.218 | 0.112 |
| Planning and execution capability | 28 | 2.64 | 0.60 | 189 | 2.94 | 0.57 | -2.643 | 0.004 |
| Logistics performance | 28 | 2.36 | 0.63 | 189 | 2.75 | 0.68 | -2.839 | 0.002 |
| IT methods and implementation | 28 | 2.77 | 0.67 | 189 | 2.97 | 0.68 | -1.477 | 0.071 |

Ho: Mean value of groups (mfg [JAP], mfg [FIN]) is the same
p-values ≤ 0.05 are highlighted

| | Non-manufacturing (FIN) | | | Non-manufacturing (JAP) | | | FIN vs JAP | |
|---|---|---|---|---|---|---|---|---|
| | *n* | *Mean* | *Stdev* | *n* | *Mean* | *Stdev* | *t-test* | *p to reject Ho* |
| Total LSC score | 25 | 60.20 | 13.06 | 101 | 57.96 | 12.05 | 0.820 | 0.207 |
| Corporate strategy & Interorganizational alignment | 25 | 3.21 | 0.67 | 101 | 3.00 | 0.63 | 1.462 | 0.073 |
| Planning and execution capability | 25 | 2.89 | 0.82 | 101 | 2.81 | 0.70 | 0.482 | 0.315 |
| Logistics performance | 25 | 2.84 | 0.83 | 101 | 2.84 | 0.75 | 0.020 | 0.492 |
| IT methods and implementation | 25 | 3.10 | 0.69 | 101 | 2.94 | 0.64 | 1.082 | 0.141 |

Ho: Mean value of groups (non-mfg [JAP], non-mfg [FIN]) is the same
p-values ≤ 0.05 are highlighted

The key results when comparing the total LSC score and the area-average scores between all Finnish and Japanese companies are:

- The average total LSC score is not statistically significantly different between Finnish and Japanese companies
- The only statistically significant area-average is the "Logistics performance" –area: the perceived level of logistics performance is higher among Japanese respondents than among Finnish respondents

The results indicate that the Finnish and Japanese companies in this study are at parity in terms of SCM-utilization, as measured with the total LSC. However, the Japanese companies give higher evaluation to their logistics performance items on average. In terms of individual LSC items Japanese companies have higher level of inventory tracking and higher level of EDI and bar code use. In terms of individual LSC items Finnish companies have a higher level of use of customer satisfaction measurement and improvement systems and use of information systems in operations and decision making.

When the analysis is focused between Finnish and Japanese manufacturing companies, the key results are:

- The Japanese manufacturing companies have a statistically significantly higher total LSC score than the Finnish manufacturing companies
- The Japanese area-average scores are statistically significantly higher in the areas of "Planning and execution capability" and "Logistics performance"

It thus seems that the Japanese manufacturing companies in the sample are clearly ahead of their Finnish counterparts in multiple LSC areas. One explanation could be the Japanese tradition of JIT-practices (Womack et al. 1990) that make use of SCM-strategies and electronic data exchange.

Finally, when considering the differences between Finnish and Japanese non-manufacturing companies the key result is that we note no statistically significant differences in total LSC or in area-average scores. It should be noted that the Japanese non-manufacturers category includes a higher proportion of logistics service providers – a fact that hinders the comparison of non-manufacturing companies between the two countries.

In sum, the statistical analysis shows that on the overall level Finnish and Japanese companies are at parity in SCM-utilization, with slight advantage of Japanese companies. However, the industry level comparison shows that Japanese manufacturing companies are much stronger than the Finnish counterparts. In non-manufacturing industries there are no statistically significant differences at the total or area score levels.

## 3.2 Factor analysis of LSC structure

An exploratory factor analysis was conducted to compare whether there is a similarity in factor structure and loadings among the Finnish and Japanese data sets. For the Japanese data set the factor analysis was conducted with the 290 observations that had complete responses to all of the 20 LSC items. As expected, the Japanese factor analysis resulted in practically the same pattern matrix as identified previously by Suzuki et al. (2006) using the whole Japanese LSC database (n=328). However, the Finnish analysis could not be completed with the factor cut-off criteria of eigenvalues over 1: the statistical software used (SPSS 13.0) could not find a solution with the five factors suggested by the principal component analysis. Since the Finnish small sample might have hindered the analysis, the analysis was performed with forcing the amount of factors to be exactly three (following the results from the larger-sample Japanese factor analysis). The final results obtained this way for Finnish and Japanese data sets are shown in Table 6.

Table 6: Results of the exploratory factor analysis with Promax rotation

| LSC item | Pattern matrix (FIN, n=53) [1] | | | Pattern matrix (JAP, n=290) [2] | | |
|---|---|---|---|---|---|---|
| | *Factor 1* | *Factor 2* | *Factor 3* | *Factor 1* | *Factor 2* | *Factor 3* |
| 1-1 | 0.556 | 0.049 | 0.077 | 0.661 | -0.011 | 0.005 |
| 1-2 | 0.844 | -0.112 | 0.037 | 0.556 | -0.051 | 0.179 |
| 1-3 | 0.504 | -0.002 | 0.145 | 0.743 | -0.170 | 0.074 |
| 1-4 | 0.345 | 0.057 | 0.340 | 0.521 | 0.348 | -0.187 |
| 1-5 | 0.364 | -0.229 | 0.564 | 0.595 | 0.068 | -0.067 |
| 2-1 | 0.512 | 0.104 | 0.215 | 0.370 | 0.250 | 0.062 |
| 2-2 | 0.165 | 0.238 | 0.303 | 0.531 | 0.132 | 0.011 |
| 2-3 | 0.078 | -0.071 | 0.824 | 0.368 | 0.324 | -0.048 |
| 2-4 | -0.112 | 0.105 | 0.635 | 0.126 | 0.439 | 0.136 |
| 2-5 | 0.028 | 0.067 | 0.659 | 0.013 | 0.509 | 0.240 |
| 3-1 | -0.213 | 0.534 | 0.511 | -0.033 | 0.707 | 0.091 |
| 3-2 | 0.466 | 0.465 | -0.122 | 0.196 | 0.576 | -0.042 |
| 3-3 | -0.065 | 0.863 | -0.118 | -0.050 | 0.772 | -0.075 |
| 3-4 | 0.249 | 0.632 | -0.037 | -0.028 | 0.613 | 0.073 |
| 3-5 | 0.182 | 0.458 | 0.119 | 0.188 | 0.346 | 0.140 |
| 4-1 | 0.356 | 0.525 | -0.166 | -0.102 | 0.240 | 0.486 |
| 4-2 | 0.604 | 0.006 | -0.066 | -0.097 | 0.260 | 0.481 |
| 4-3 | -0.280 | 0.690 | 0.248 | 0.293 | 0.016 | 0.336 |
| 4-4 | 0.281 | 0.347 | -0.010 | 0.015 | -0.127 | 0.792 |
| 4-5 | 0.228 | -0.061 | 0.496 | 0.174 | 0.006 | 0.527 |

Factor loadings ≥ 0.4 are highlighted

1) Extraction method: Principal Axis factoring; Rotation: Promax with Kaiser normalization; forced solution with three factors.

2) Extraction method: Principal Axis factoring; Rotation: Promax with Kaiser normalization; cut-off criteria for the selection of the number of factors: eigenvalue > 1.

The key results of the factor analysis are:

- The similarity of factor structure could not be compared. The Finnish data set seems to have been too small to find a solution for the eigenvalue-over-1 criteria. Therefore the study was unable to provide evidence whether the factor structure identified previously by Suzuki et al. (2006) using the Japanese data holds in international context.
- Comparing the similarity of factor loadings with three factor solutions in both data sets revealed that the solution is similar, but by far not the same. The interpretations for the three factors in the Finnish data set are different than for the Japanese data set.
- The Finnish three factors resemble mainly the first three areas of the LSC. There is no separate IT-factor, but rather the IT items are fragmented among the three factors. This is different than for the Japanese data, where a separate IT-factor can be found and where one of the three factors is a combination of two LSC areas (the second and third).

Perhaps the most surprising finding of the factor analysis is that the "IT methods and implementation" items did not load in a single factor among the Finnish data. Instead, the individual LSC items loaded with different factors:

- Item 4-2 (use of bar coding) loaded with Factor 1 (close to the LSC area "Corporate strategy & interorganizational alignment")
- Items 4-1 (use of EDI) and 4-3 (use of computers in decision making and operations) loaded with Factor 2 (close to the LSC area "Logistics performance")
- Item 4-5 (decision making systems with supply chain partners) loaded with Factor 3 (close to the LSC area ""Planning and execution capability")

This result is in stark contrast with results of the factor analysis Japanese data among which a clear "IT-factor" can be found. There are several possible explanations for this puzzling result:

1. The Finnish data set might just be too small for a valid factor analysis
2. The items for LSC area of IT might not represent the use of IT for the Finnish companies in the similar way as for the Japanese companies
3. For Finnish companies the use IT is embedded in various areas of SCM, while for Japanese it is a distinct area

It would be tempting to conclude alternative 2 or 3 – that there are differences in the ways Finnish and Japanese companies view the role of IT in SCM. However, making this kind of conclusion would go too far, since it would be based almost purely on speculation. Further analysis with significantly higher number of observations from Finland would be needed to examine this issue more rigorously.

## 3.3 LSC and financial performance

### 3.3.1 Overall analysis

To examine to which extent the LSC scores of companies and their financial performance in 2005 are related, a correlation analysis was performed. The evaluation was conducted within the Finnish data using (1) the total LSC scores and the three factors identified in Table 6 above and (2) the financial indicator variables as described in Table 2 above. It should be noted that there might be lags between SCM practices and financial performance. As for the Japanese data set, Suzuki et al. (2006) found that LSC data collected in year *t* correlated significantly with measure of cash flow from year *t+1* and return on assets from year *t+2*, providing possibility to interpret a leading indicator structure of the effects. This kind of evaluation of lags was not possible in this study since both the LSC and financial performance data were very recent.

The results of the correlation analysis on the overall level of Finnish data are presented in Table 7. Note that the financial indicator variables used do not fill the normality assumption needed for the correlation tests. Therefore, the statistical significances should be interpreted with caution.

Table 7: Results of the LSC-financial performance correlation analysis (Finnish data set)

| | ROI-05 | | | Inv.DOS-05 | | | Inv/sales-05 | | | CF/sales 05 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Corr* | *p* [1)] | *n* | *Corr* | *p* [1)] | *n* | *Corr* | *p* [1)] | *n* | *Corr* | *p* [1)] | *n* |
| Total LSC score | 0.18 | 0.202 | 44 | -0.08 | 0.372 | 40 | -0.18 | 0.200 | 45 | 0.00 | 0.494 | 45 |
| Factor 1 | 0.32 | 0.063 | 44 | -0.26 | 0.127 | 40 | -0.22 | 0.149 | 45 | -0.03 | 0.448 | 45 |
| Factor 2 | 0.02 | 0.472 | 44 | 0.14 | 0.267 | 40 | -0.07 | 0.365 | 45 | 0.02 | 0.463 | 45 |
| Factor 3 | 0.16 | 0.233 | 44 | -0.11 | 0.316 | 40 | -0.13 | 0.273 | 45 | 0.03 | 0.452 | 45 |

p-values ≤ 0.10 are highlighted
1) p to reject Ho (Corr = 0)

As can be seen from Table 7, without one exception all the correlation coefficients are statistically insignificant. Therefore, the estimated correlation coefficients might as well be spurious, as a result of random variation. The only statistically significant correlation coefficient

is that of between ROI and Factor 1 (loading closely with LSC area "Corporate strategy & interorganizational alignment"). The estimated linear correlation is 0.32, indicating a mildly positive relationship with higher Factor 1 scores with higher ROI values.

However, Table 7 shows also that the observed correlation coefficients are well in line with the expected sign of the correlation coefficients. For example, there is a positive association between total LSC score and ROI and inverse relationship between total LSC score and inventory commitment. In fact, the only two exceptions from predicted are that for Factor 1 the sign for correlation with the cash flow measure is negative, and for Factor 2, the sign for the inventory days of supply –measure is positive. It should also be noted that the cash flow correlation coefficient estimates are very close to zero, providing indication of the irrelevance of this financial indicator in terms with LSC score variation. This result is clearly different with the Japanese results, where a similar cash flow measure at time *t+1* was observed to correlate significantly with LSC data collected at time *t*.

### 3.3.2 Classification analysis

As reported above, the LSC evaluation is based on a 1-5 scale, with the middle point described as an average level. It could be posited that SCM-practices have real impact only after certain threshold. Suzuki et al. (2006) classified the Japanese sample into two groups, with below zero and above zero factor scores. Within the below zero group, only weak relationship with financial indicator was noticed. On the other hand, for those companies that the score exceeded zero, a higher positive correlation was noted.

Following this line of analysis, the Finnish sample was divided into two groups. Companies with total LSC score over median value were classified in the "high" group; others in the "low" group. Companies with factor scores over zero were classified in the "high" group for each factor; other

companies in the "low" group for each factor. Table 8 summarizes the results of the correlation coefficient analysis within the groups.

Table 8: Results of the LSC-financial performance correlation analysis with groupings of respondents (Finnish data set)

| | ROI-05 | | | Inv.DOS-05 | | | Inv/sales-05 | | | CF/sales 05 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Corr* | *p* [1)] | *n* | *Corr* | *p* [1)] | *n* | *Corr* | *p* [1)] | *n* | *Corr* | *p* [1)] | *n* |
| High total LSC score [2)] | 0.26 | 0.221 | 24 | -0.58 | 0.049 | 20 | -0.57 | 0.030 | 24 | 0.01 | 0.492 | 24 |
| Low total LSC score [2)] | 0.22 | 0.296 | 20 | -0.14 | 0.370 | 20 | 0.14 | 0.363 | 21 | 0.03 | 0.465 | 21 |
| High Factor 1 score [3)] | 0.46 | 0.076 | 24 | -0.24 | 0.261 | 21 | -0.48 | 0.062 | 24 | -0.02 | 0.475 | 24 |
| Low Factor 1 score [3)] | 0.30 | 0.226 | 20 | 0.10 | 0.411 | 19 | 0.26 | 0.250 | 21 | -0.15 | 0.351 | 21 |
| High Factor 2 score [3)] | -0.21 | 0.291 | 21 | 0.06 | 0.451 | 18 | -0.20 | 0.300 | 21 | -0.01 | 0.491 | 21 |
| Low Factor 2 score [3)] | 0.12 | 0.372 | 23 | -0.33 | 0.180 | 22 | 0.04 | 0.458 | 24 | 0.11 | 0.378 | 24 |
| High Factor 3 score [3)] | 0.51 | 0.064 | 22 | -0.37 | 0.191 | 18 | -0.39 | 0.133 | 22 | 0.30 | 0.207 | 22 |
| Low Factor 3 score [3)] | 0.12 | 0.377 | 22 | 0.13 | 0.367 | 22 | 0.07 | 0.427 | 23 | 0.18 | 0.306 | 23 |

p-values ≤ 0.10 are highlighted

1) p to reject Ho (Corr = 0)

2) Respondents were grouped into "high" total LSC group if their total LSC score was same or higher than the median total score and to "low" total LSC group if their total LSC score was lower than the median score.

3) Respondents were grouped into "high" factor score group if their factor score was ≥ 0, and to "low" group if < 0.

With the partition of the data set, more correlations become statistically significant. Especially low inventory commitment seems to be associated with higher LSC scores, but only in the group of higher than median LSC scores. One possible interpretation is that SCM-development efforts start to have operational impact in terms of lower inventory commitment only after a certain threshold level of SCM is reached. There is also mild support that the items in the LSC area 1 (loading with Factor 1) would be positively associated with return on investment. This relationship also seems to be stronger among companies with item scores higher than average.

In summary, the correlation analysis suggests that the financial indicator variables, except the cash flow measure, correlate with expected sign with LSC scores in the Finnish data set, as noted also in the Japanese data set. That is, a higher LSC score is associated with a better financial

score. This seems visible especially among the group of higher LSC-score holders, possibly indicating a threshold after which SCM-efforts start to bring visible results. The correlation analysis is, however, only indicative, since the Finnish data set was very small, and also for the reason that the financial indicator variables were not normally distributed.

# 4 DISCUSSION: POTENTIAL SOURCES OF BIAS IN THE STUDY AND IN THE LSC

It is important to pay attention to several sources of bias in the results presented in this paper. Firstly, Japanese data collection has been carried out since 2001, while Finnish data has been collected in 2004 and 2006. Therefore, the results may not be perfectly comparable, since all the responses are not from a single point of time. Moreover, Japanese data has been collected first with personal interviews and later also with e-mail communication (Suzuki et al. 2006). Finnish data has been collected with e-mail communication and with web-based system. The different data collection methods may induce bias to the results.

In international research environments, different languages pose also threats to validity of study instruments across countries. The Japanese data has been collected with Japanese version of the LSC. Data collected from Finland were collected with a Finnish version that had been translated from the English version of the Japanese LSC. Some differences between Japanese and Finnish answers noted in this study might be a result of differences of the items in local languages. Moreover, even if the translations were word-for-word the same, cultural differences might still make differences, since people in different countries might understand different things differently.

Difference in the sample profiles makes also the comparison harder. The Japanese sample includes on average much larger companies than the Finnish sample. This result may further

make the comparison difficult. It may favor the Japanese sample, since it could be assumed that larger companies have more resources for various development efforts and thus may also have more resources for SCM in general and for SCM-related technologies, such as EDI, in particular. A more realistic comparison should be made with companies of similar sizes from both countries. This comparison was out of the scope of this analysis work. In addition, there is a higher proportion of logistics service providers among the non-manufacturing companies in the Japanese data set than there is in the Finnish data set.

One additional possible source of bias is the small number of Finnish companies. This has at least two implications. Firstly, the responses of the Finnish companies should not be considered as respective of all Finnish companies. Secondly, small number of Finnish companies makes use of statistical methods, such as the Pearson moment correlation and exploratory factor analysis very susceptible. Therefore the results of Finnish data on, for example, the factor structure of the LSC, are tentative rather than definite. Differences between the factor structures in Japanese and Finnish data sets might be solely a result of the small Finnish data set.

The results of the correlation analyses might be undermined also – besides small sample size of Finnish companies and apparent non-normality of financial indicator variables – by the fact that all financial indicator variables could not be collected for the same entity that gave the LSC answers. The group level ROI, inventory commitment, and cash flow measures might not be in perfect match between the respondent level indicators. However, it was impossible for this study to have for all respondents the respondent level indicators. With this study we only can assume that there is a strong enough relationship between the group-level financial indicators also for those respondents who are parts of these groups and from whom respondent level data was not available.

On a more general level, the validity of the LSC could be discussed. There is an apparently strong numerical basis for the LSC: it was developed based on various existing (managerially oriented) scorecards and using numerical methods to define the LSC. However, two points should be stressed. The evaluation of various scorecards is based on subjective scores and thus may not be as objective as would be thought. Second, the managerial scorecards as the background of LSC might not include all relevant aspects in terms of SCM. Thus it is not said that the LSC is the best possible measuring scheme of SCM practices. Examining the academic literature might provide insights to develop the LSC to be of more universal appeal. However, the LSC is at the very least an interesting opening towards systematic evaluation of inter-company SCM practices.

Taken together, these possible sources of bias pose serious concerns over the comparability of the results. Therefore, the comparison of Japanese and Finnish companies should be taken only as suggestive. It goes too far to conclude that there are true significant differences between the whole populations of companies in these two countries. However, the results of this report provide still interesting insights, and raises important questions such as whether the Finnish non-manufacturing industries are in fact ahead of the manufacturing industries and whether Japanese manufacturers are stronger in SCM than the Finnish, or are the Finnish respondents just too modest to bolster themselves. In any case the LSC opens up a basis – yet to be developed further – to start to discuss the differences of SCM utilization aspects in a multinational context.

# 5 CONCLUSION

This study has examined the differences between a set of Finnish and Japanese companies using the SCM logistics scorecard (LSC) developed originally by the Tokyo Institute of Technology. The most notable findings are that while on overall level Finnish and Japanese companies are equals, Japanese manufacturers outstrip their Finnish counterparts and but not their non-

manufacturing counterparts. The relative strength of the Japanese manufacturers might be due to the tradition of JIT-manufacturing practices. Factor analysis revealed a similar latent factor structure emerging within the data sets of the both countries, with certain differences: the most prominent being that the IT methods were not identified as a unique factor in the Finnish data set as in the Japanese data set. Comparison with financial indicator variables among the Finnish data set provided mild support that LSC or LSC-based factor scores are positively associated with better performance, and that this effect would be more visible among companies with higher scores. This result was similar as in the Japanese data. However, the lag-structure of LSC-financial performance observed with the Japanese data set could not be tested with the Finnish sample, as only recent LSC and financial indicator data were available.

We conclude that even with the notable shortcomings (for example lack of rigor in the translation of questions, lack of academic basis of the items), LSC is an interesting tool for comparison of SCM practices in the international context. Besides developing the validity of the tool itself, further evaluation of international studies with the LSC are needed to evaluate the suitability of the instrument for international studies. This work is currently under way, as data from Thailand and China have already been collected and analyzed (see for example Yaibuathet et al. 2006). The paper indicates also that LSC can be well used in line with external data and conduct meaningful analysis on the correlates of SCM practices. Further analysis with the LSC and external data should take more holistically use of the received theory and use more clearly a theoretical lens to interpret the empirical observations

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# APPENDIX: THE SCM LOGISTICS SCORECARD (LSC)

| Area | Item | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 |
|---|---|---|---|---|---|---|
| 1. Corporate strategy & Interorganizational alignment | **(1-1) Corporate strategy regarding logistics and its importance** | Top executives have not formulated a strategy or policy regarding logistics/SCM. No department has responsibility for logistics/SCM improvement or innovation. | A department with responsibility for logistics system innovation exists, but action is limited to that department. Logistics/SCM strategy is not clearly defined. Top mgmt not actively involved. | Under leadership of a top executive, there is a program for logistics/SCM innovation, but the program does not extend company-wide. | Supported by a clear corporate-level strategy, a top executive (managing executive director or above) leads efforts for logistics/SCM innovation. The innovation program is making progress. | Under the CEO's leadership and a clear corporate strategy, there is an company-wide system that supports rapid adaptation of the supply chain to environmental change. |
| | **(1-2) Definition of supplier contract terms & degree of information sharing** | No formal, written agreement or info sharing with main suppliers. Decision making is done independently. | Formal, written agreements exist with some suppliers. Agreements with other suppliers are under consideration | Formal, written agreements exist with some suppliers, but the agreements are not necessarily based on win-win solutions for both parties. | Formal, written agreements exist with nearly all suppliers. Some of these are aimed at win-win solutions based on info sharing. | Formal, written agreements exist with nearly all suppliers. Company has a well-established approach for seeking win-win solutions based on strategy and info sharing. |
| | **(1-3) Definition of customer contract terms & degree of information sharing** | No formal, written agreement or info sharing with main customers. Decision making is always done by customers. | Formal, written agreements with customers are under consideration | Formal, written agreements exist with some customers, but the agreements are not necessarily based on win-win solutions for both parties. | Formal, written agreements exist with nearly all customers. Company has a partly-established approach for seeking win-win solutions based on info sharing under a leadership of customers. | Formal, written agreements exist with nearly all customers. Company has a well-established approach for seeking win-win solutions based on strategy and info sharing. |
| | **(1-4) System for measurement and improvement of customer satisfaction** | No clear definition of customers. Customer complaints are resolved in a temporary and expedient way. | There is a clear definition of customers. However, there are no periodic surveys of customer satisfaction levels; no record of customer complaints is kept. | Periodic surveys of customer satisfaction levels are carried out. However, the survey results are acted upon only by the sales dept., with low cross-functional involvement. | Periodic, quantitative surveys of customer satisfaction levels are carried out. There is cross-functional involvement to improve customer satisfaction. | In addition to Level 4, the results of customer satisfaction surveys are shared with relevant customers and are used in the joint development of products/services. |
| | **(1-5) System for employee training and evaluation** | No particular training program exists to develop employee abilities to achieve customer satisfaction and system optimization. | Company slogans dealing with customer satisfaction or system optimization exist, but there are no corresponding training programs. | A training program for increasing employee abilities to achieve customer satisfaction and system optimization exists and is put into practice. | Meets Level 3, and in addition, the employee evaluation system directly considers employee abilities to achieve customer satisfaction and system optimization. Training leads to increased employee empowerment.. | In addition to Level 4, there is a knowledge management system for sharing knowledge and know-how at the team and organization level. |
| 2. Planning and execution capability | **(2-1) Strategies for optimizing logistics system resources based on design for logistics** | Efficienct utilization of logistics facilities and resources is not seen as a problem. No improvement strategy exists. | Importance of optimizing logistics system resources is recognized, but there is no strategic plan or review. | Strategic plan exists for review of transportation modes and inventory allocation among plant, distribution center, transfer center. Optimization efforts are making progress. | In addition to Level 3, suppliers and customers are involved in efforts to optimize logistics systems resources. | Clear strategy exists for collaboration and optimization across the supply chain, including product re-design based on design for logistics, and use of other approaches such as joint distribution and category management. |
| | **(2-2) Understanding of market trends & accuracy of demand forecasting** | Rely on the experience and judgment of the sales department to predict market trends and forecast demand. | Demand forecasting for certain products is based on a quantitative sales history combined with the judgment and experience of the sales department. | Demand forecasting for key products is based on an analysis of market trends and quantitative sales history, and includes the input of sales and related departments. | Level 3 approach is extended to all products, and forecasts for key products are broken down into items or categories. Demand forecasting system is in place. | Level 4 approach is carried out jointly with supply chain partners. Demand forecasts can be revised dynamically for changing market conditions. |
| | **(2-3) Accuracy and adaptability of SCM planning** | Planning for sales, replenishement and delivery is carried out separately, without consideration of inventory availability. | Plans for sales, replenishment, and delivery are intended to be coordinated with each other on a monthly basis, but in practice this is only partially achieved. | Plans for sales, replenishment and delivery are supposed to be coordinated with each other on a weekly basis, but individual departments may make their own adjustments during the week. | Linkage of weekly plans between departments is done on a rolling basis. Plan adjustments for customers can be done on a daily basis. | Linkage of daily plans between departments is done on a rolling basis. Plan adjustments for suppliers or customers can be done on an hourly basis. |
| | **(2-4) Control and tracking of inventory (product/parts/WIP): accuracy and visibility** | No tracking or visibility of inventory/WIP status. Management action is taken after-the-fact. | For most items, inventory status is tracked on a daily basis, and supply is adjusted to meet demand on a monthly basis. | A system is in place which enables the company to manage and track its own inventory and replenishment activities on a daily basis. | A system is in place which enables the company to manage and track inventory and replenishment activities for iself and its suppliers on a daily/hourly basis. | Inventory and replenishment activities are managed and tracked throughout the entire supply chain, including suppliers and customers. Information is strategically shared. |
| | **(2-5) Process standardization and visibility** | Little standardization of work methods or use of unit loads. Some process activities are treated as a "black-box". | Work methods are mostly standardized, but the overall work flow is not completely visible. | Work methods are standardized and unit loads are used, but interface activities with suppliers and customers are not made sufficiently visible. | Work flow, including interface activities with suppliers and customers, is standardized and made visible. There is continous improvement of work activities within the company. | In addition to Level 4, partnerships are established for each business unit and the entire supply chain is made visible. Process innovation is continually pursued. |
| 3. Logistics Performance | **(3-1) Just-In-Time (elimination of idle time and setup time through information sharing and synchronization of material and information flow)** | Just-in-time philosophy is not part of the company's approach or practices | Company recognizes the importance of JIT philosophy, but has not implemented JIT practices in production, replenishment, material handling, or delivery. | JIT practices such as setup time reduction, lot-size reduction, load consolidation or floor-ready merchandise are implemented, but they are not synchronized with other activities. | Some JIT activities are synchronized (e.g. picking sequence is determined from delivery plan, delivery trucks allocated based on picking sequence, etc). | JIT activities are synchronized throughout the material flow and involve suppliers and customers. |
| | **(3-2) Inventory turnover & cash-to-cash cycle time** | Neither inventory turns nor cash-to-cash cycle time are measured. Inventory turnover is low, and cash flow is poor. | Inventory turnover is known at the aggregate level for each facility, but inventory management is not linked to cash flow. | Inventory turnover for each supplier and individual product is measured with accuracy at the week-level and actual performance level of less than 12 turns/year. | Inventory turnover for each supplier and SKU is measured with accuracy at the day-level and actual performance level of 12+ turns/year. Inventory management is linked with cash flow. | Exceeds Level 4, with inventory measured with accuracy at the hours-level and actual performance of 24+ turns/year. Cash-to-cash cycle time is less than 10 days. |
| | **(3-3) Customer lead time (from order placement to receipt) and load efficiency** | Lead time from order placement to receipt is long. Company receives frequent requests from customer to shorten lead time. | Lead times for different customer categories are known, but orders with short lead time are covered by on-hand inventory. Little effort made to reduce lead times. | Lead time is known and managed for each customer or item category, and is linked to truck allocation planning to increase load efficiency. | In addition to Level 3, average lead time is less than 2 days. Continuous efforts made to further reduce lead times. | In addition to Level 4, achieves load efficiency of 80% or higher. |
| | **(3-4) Delivery performance and quality** | On-time delivery rate (on-time deliveries / total orders) and order fulfillment accuracy (accurate deliveries / total orders) are not known. Company faces many customer complaints. | On-time delivery rate and order fulfillment accuracy are measured, but actual performance level is less than 95%. | Performance is between 95 and 99% for both rates. To improve performance, efforts are made to collect data on the root causes of late deliveries, stock outs, misdeliveries, damage, etc. | Performance exceeds 99% for both rates. Based on data about root causes, error prevention measures such as mistake-proofing are implemented on an ongoing basis. | In addition to Level 4, suppliers and customers are involved in improvement efforts. While maintaining high performance, efforts to improve efficiency, such as elimination of incoming inspections, are promoted. |
| | **(3-5) Supply chain inventory visibility & opportunity costs** | Only on-hand inventories within one's own facility or company are known. Opportunity cost of lost sales is not known or estimated. | Inventory levels within the company are known. Some estimation is made of the opportunity cost of lost sales. | Inventory levels are known for the company and its immediate suppliers **or** customers. Some estimation is made of opportunity cost of lost sales for the company only. | Inventory levels are known for the company and its immediate suppliers **and** customers. Some estimation is made of opportunity cost of lost sales for the company only. | Inventory levels are known throughout the entire supply chain. Estimation is made of opportunity cost of lost sales at the end demand level. |
| 4. IT methods and implementation | **(4-1) Electronic Data Interchange (EDI) coverage** | Company is not electronically linked to any customer or supplier. | EDI links are set up with some customers or suppliers at their request. | EDI is used with over 50% of customers or suppliers. Proprietary EDI standards are used in most cases. | In addition to Level 3, EDI is integrated with the company's internal systems so that manual re-entry of data is not necessary in most cases. | EDI is used for nearly all transactions and is integrated with internal systems. Open standards for EDI are adopted or in-process of adoption. |
| | **(4-2) Usage of Bar Coding / Automatic Identification and Data Capture (AIDC)** | Bar codes or other forms of automatic identification and data capture (AIDC) are not utilized. | Bar codes are utilized in some activities such as inspection, but the data is not used for other purposes. | Bar codes are utilized in some activities, such as inspection, and the data is shared with internal systems to synchronize the material and information flow. | Extending the scope of Level 3, bar codes are used as a means to accelerate innovation of the logistics system, in addition to synchronizing the material and information flow. | The best mix of bar codes, 2-dimensional symbols, IC tags and other AIDC methods is linked with EDI, and used to support innovation of the logistics system at the supply chain level. |
| | **(4-3) Effective usage of computers in operations and decision-making (ERP, supply chain planning software, etc.)** | PCs are not utilized anywhere in the business. | PCs are used to support some business operations and activities. | Most routine business operations and activities are computerized (e.g. accounting, production, etc.) but are not integrated with each other. | In addition to Level 3, decision support systems and other IT tools are utilized for logistics planning and optimization. | ERP, SCP, CRM and other IT tools are utilized for planning and optimization of the entire supply chain. Outsourcing and other means are considered for increasing the effective use of IT and related resources. |
| | **(4-4) Open standards and unique identification codes** | Company has no awareness of open standards and unique identification codes. | Company understands the importance of open standards and unique identification codes for improving the efficiency of logistics processes. | To exploit the potential of IT, unique identification codes are used within the company and process simplification is also carried out. | In addition to Level 3, usage of unique identifiers is extended to suppliers and/or customers. Open standards for EDI and other IT applications are adopted or under consideration. | In addition to Level 4, unique identification codes are extended to both suppliers and customers. Company is actively working towards adoption of open standards for EDI and other IT applications. |
| | **(4-5) Decision-making systems and support to supply chain partners** | No knowledge or interest in the decision-making processes and systems used by suppliers or customers. | Has a general understanding of how a supplier or customer makes its decisions, but does not know the details of the systems used. | Understands the systems used by a supplier or customer, but has made no proposals or efforts to bring about a win-win solution. | Exploring ways to modify or integrate the systems of the company and its suppliers or customers in order to realize win-win solutions. | Have succeeded in implementing a win-win solution with supply chain partners, and actively provide proposals and support to partners to improve their systems and innovate the supply chain. |